

AMENDMENTS TO THE CLAIMS

The following listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (Currently Amended) A semiconductor force sensor comprising:
a semiconductor force sensor element including a diaphragm section having a converting section for converting a change in a force into a change in an electric signal by piezoresistive effect;
~~force transmitting means for applying the force to be measured to said diaphragm section of said semiconductor force sensor element, said force transmitting means being constituted by a sphere having rigidity; and~~
a force transmitting means positioning structure having an opposed wall section spaced from said diaphragm section and arranged to face said diaphragm section, for positioning and arranging said force transmitting means so that said force transmitting means is brought into direct contact with a central portion of said diaphragm section,
~~said force transmitting means being constituted by a sphere having rigidity;~~
wherein a through hole passing through said opposed wall section in a direction toward said diaphragm section is formed in said opposed wall section of said force transmitting means positioning structure at a position facing said central portion of said diaphragm section; and

said through hole is so shaped that a part of said sphere faces an outside of said opposed wall section therethrough and receives a part of a remainder of said sphere so that said sphere can move only in a direction orthogonal to said diaphragm section and can rotate on said central portion of said diaphragm section; and

said through hole comprises:

a first through hole portion located on a side of the diaphragm section and at a position corresponding to a lower half of said sphere:

a second through hole portion located on a side of said outside; and
a third through hole portion located between said first through hole portion and said second through hole portion; and

said first through hole portion has a constant diameter size slightly larger than a diameter of said sphere, said second through hole portion has a constant diameter size allowing said part of said sphere to be exposed to said outside from said second through hole portion, and said third through hole portion is so shaped that a diameter size thereof decreases more toward said second through hole portion from said first through hole portion along an outer surface of said sphere.

2. (Original) The semiconductor force sensor according to claim 1, wherein said diaphragm section has a front surface with said converting section formed thereon and a back surface located opposite to said front surface; said semiconductor force sensor element has a cylindrical base section formed integrally with a periphery of said back surface of said diaphragm section;

and

 said sphere is arranged to apply said force to said front surface of said diaphragm section.

3. (Cancelled)

4. (Currently Amended) ~~The semiconductor force sensor according to claim 1, wherein~~ A semiconductor force sensor comprising:

a semiconductor force sensor element including a diaphragm section having a converting section for converting a change in a force into a change in an electric signal by piezoresistive effect;

force transmitting means for applying the force to be measured to said diaphragm section of said semiconductor force sensor element, said force transmitting means being constituted by a sphere having rigidity; and

a force transmitting means positioning structure having an opposed wall section spaced from said diaphragm section and arranged to face said diaphragm section, for positioning and arranging said force transmitting means so that said force transmitting means is brought into direct contact with a central portion of said diaphragm section,

wherein a through hole passing through said opposed wall section in a direction toward said diaphragm section is formed in said opposed wall section of said force transmitting means positioning structure at a position facing said central portion of said diaphragm section;

said through hole is so shaped that a part of said sphere faces an outside of

said opposed wall section therethrough and receives a part of a remainder of said sphere so that said sphere can move only in a direction orthogonal to said diaphragm section and can rotate on said central portion of said diaphragm section;

said through hole comprises a first through hole portion located on a side of said diaphragm section and a second through hole portion located on a side of said outside; and

said first through hole portion has a constant diameter size slightly larger than a diameter of said sphere, and said second through hole portion is so shaped that a diameter size thereof gradually decreases toward said outside so as to allow said part of said sphere to be exposed to said outside from said second through hole portion.

5. (Original) The semiconductor force sensor according to claim 2, wherein a side of said diaphragm section on which said sphere is located is covered with a gel-like protective agent having electrically insulating property; and

 penetration of said gel-like protective agent is so defined that said sphere pushes away said gel-like protective agent on said diaphragm section to substantially come in direct contact with said central portion of said diaphragm section.

6. (Currently Amended) A semiconductor force sensor comprising:
 a semiconductor force sensor element including a diaphragm section having a converting section for converting a change in a force into a change in an electric signal by piezoresistive effect;

a sphere having rigidity for applying the force to be measured to said diaphragm section of said semiconductor force sensor element;

a case main body having one open surface, including an opening in said one open surface and a sensor element supporting section for supporting said semiconductor force sensor element at a position facing said opening so that deformation of said diaphragm section is allowed;

a lid member including an opposed wall section facing said diaphragm section of said semiconductor force sensor element supported by said sensor element supporting section and fixed to said case main body so as to close said opening; and

a through hole formed in said opposed wall section, for receiving said sphere; said through hole being so shaped that a part of said sphere faces an outside of said opposed wall section therethrough and receives a part of a remainder of said sphere so that said sphere can move only in a direction orthogonal to said diaphragm section and can rotate on a central portion of said diaphragm section with said sphere being in direct contact with said central portion of said diaphragm section;

said through hole comprising:

a first through hole portion located on a side of the diaphragm section and at a position corresponding to a lower half of said sphere;

a second through hole portion located on a side of said outside; and

a third through hole portion located between said first through hole portion and said second through hole portion; and

said first through hole portion has a constant diameter size slightly

larger than a diameter of said sphere, said second through hole portion has a constant diameter size allowing said part of said sphere to be exposed to said outside from said second through hole portion, and said third through hole portion is so shaped that a diameter size thereof decreases more toward said second through hole portion from said first through hole portion along an outer surface of said sphere.

7. (Original) The semiconductor force sensor according to claim 6, wherein said diaphragm section has a front surface with said converting section formed thereon and a back surface located opposite to said front surface;

 said semiconductor force sensor element has a cylindrical base section integrally formed with a periphery of said back surface of said diaphragm section; and

 said sphere is arranged to apply said force to said front surface of said diaphragm section.

8. (Cancelled)

9. (Currently Amended) ~~The semiconductor force sensor according to claim 6, wherein said through hole comprises~~ A semiconductor force sensor comprising:
a semiconductor force sensor element including a diaphragm section having a converting section for converting a change in a force into a change in an electric signal by piezoresistive effect;

a sphere having rigidity for applying the force to be measured to said

diaphragm section of said semiconductor force sensor element;

a case main body having one open surface, including an opening in said one open surface and a sensor element supporting section for supporting said semiconductor force sensor element at a position facing said opening so that deformation of said diaphragm section is allowed;

a lid member including an opposed wall section facing said diaphragm section of said semiconductor force sensor element supported by said sensor element supporting section and fixed to said case main body so as to close said opening; and

a through hole formed in said opposed wall section, for receiving said sphere; said through hole being so shaped that a part of said sphere faces an outside of said opposed wall section therethrough and receives a part of a remainder of said sphere so that said sphere can move only in a direction orthogonal to said diaphragm section and can rotate on a central portion of said diaphragm section with said sphere being in direct contact with said central portion of said diaphragm section;

said through hole comprising:

a first through hole portion located on a side of said diaphragm section and a second through hole portion located on a side of said outside; and

said first through hole portion has a constant diameter size slightly larger than a diameter of said sphere, and said second through hole portion is so shaped that a diameter size thereof gradually decreases toward said outside so as to allow said part of said sphere to be exposed to said outside from said second through hole portion.

10. (Original) The semiconductor force sensor according to claim 7, wherein, with said base section being joined to said sensor element supporting section of said case main body, a gel-like protective agent having electrically insulating property is filled in said case main body so as to cover said diaphragm section; and

penetration of said gel-like protective agent is so defined that said sphere pushes away said gel-like protective agent on said diaphragm section to substantially come in direct contact with said central portion of said diaphragm section.

11. (Currently Amended) A semiconductor force sensor comprising:
a semiconductor force sensor element including a diaphragm section having
a converting section for converting a change in a force into a change in an electric
signal by piezoresistive effect;
a sphere having rigidity for applying the force to be measured to said
diaphragm section of said semiconductor force sensor element;
a case main body having one open surface, including an opening in said one
open surface and a sensor element supporting section for supporting said
semiconductor force sensor element at a position facing said opening so that
deformation of said diaphragm section is allowed;
a lid member including an opposed wall section facing said diaphragm
section of said semiconductor force sensor element supported by said sensor
element supporting section and fixed to said case main body so as to close said

opening; and

a through hole formed in said opposed wall section, for receiving said sphere;
said through hole being so shaped that a part of said sphere faces an outside
of said opposed wall section therethrough and receives a part of a remainder of said
sphere so that said sphere can move only in a direction orthogonal to said
diaphragm section and can rotate on a central portion of said diaphragm section
with said sphere being in direct contact with said central portion of said diaphragm
section;

The semiconductor force sensor according to claim 6, wherein said case main body ~~comprises~~ comprising a bottom wall section constituting said sensor element supporting section, a peripheral wall section having one end thereof integrally formed with a peripheral edge portion of said bottom wall section and the other end thereof formed so as to surround said opening, and a plurality of fitting protrusions provided on the other end of said peripheral wall section, and is integrally formed of an electrically insulating resin material;

said lid member ~~includes~~ including a plurality of fitted through holes and is integrally formed of an electrically insulating resin material, said plurality of fitting protrusions of said case main body passing through said plurality of the fitted through holes; and

said lid member ~~is~~ being fixed to said case main body by thermal deformation of leading edge portions of said plurality of the fitting protrusions protruding from said lid member, with said plurality of the fitting protrusions of said case main body being fitted into said plurality of the fitted through holes in said lid member.

12. (Original) The semiconductor force sensor according to claim 11, wherein a recess portion or stepped portion for receiving said fitting protrusion thermally deformed is formed around said fitted through hole in said lid member.

13. (Original) The semiconductor force sensor according to claim 11, wherein a pair of recess portions are formed at a pair of opposed locations facing each other in an outer wall portion of said peripheral wall section, said pair of the recess portions being open outwardly and toward the other end of said peripheral wall section; and

a pair of positioning protrusions are integrally formed with said lid member, said pair of the positioning protrusions extending from said opposed wall section toward said case main body and being fitted into said pair of the recess portions.

14. (Original) The semiconductor force sensor according to claim 6, wherein said case main body and said lid member are respectively formed of ceramics.

15. (Currently Amended) The semiconductor force sensor according to claim 6, wherein said case main body is formed of ceramics and said lid member is formed of a metal.

16. (Original) The semiconductor force sensor according to claim 10, wherein said case main body is provided with a communicating passage for communicating a space bordered by said base section and said diaphragm section

with an outside of said case main body.

17. (Original) A surface-mount type semiconductor force sensor comprising:

 a semiconductor force sensor element including a diaphragm section having a converting section for converting a change in a force into a change in an electric signal by piezoresistive effect;

 a sphere having rigidity for applying the force to be measured to said diaphragm section of said semiconductor force sensor element:

 a case main body having one open surface and formed of a synthetic resin, said case main body including an opening in said one open surface and a sensor element supporting section for supporting said semiconductor force sensor element at a position facing said opening so that deformation of said diaphragm section is allowed;

 a lid member including an opposed wall section facing said diaphragm section of said semiconductor force sensor element supported by said sensor element supporting section and fixed to said case main body so as to close said opening;

 a through hole formed in said opposed wall section, for receiving said sphere; and

 a plurality of terminals fixed to said case main body by insert molding; said through hole being so shaped that a part of said sphere faces an outside of said opposed wall section therethrough and receives a part of a remainder of said sphere so that said sphere can move only in a direction orthogonal to said diaphragm section and can rotate on a central portion of said diaphragm section

with said sphere being in direct contact with said central portion of said diaphragm section; and

 said plurality of the terminals protruding from said case main body to enable surface mounting.